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Testing FARM SEED

AGRICULTURAL EXPERIMENT STATION—AGRICULTURAL EXTENSION SERVICE, Cooperating
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Testing Farm Seed[1]

By R. H. Porter[2]

Iowa is a major crop- and seed-producing area. More acres of corn and oats are grown in Iowa than in any other state, and most of the seed of these crops for Iowa farmers is produced within the state. Furthermore, in 1943 over 95 percent of the corn acreage was planted with hybrid seed, and over 60 percent of the oat acreage was planted with seed of new rust-resistant varieties. Other seed crops of importance in Iowa are soybeans, bluegrass, timothy, wheat, flax, bromegrass, red clover, sweet clover, sudan grass, sweet corn, watermelon and sorghum. The yield and quality of a crop harvested each year is dependent in part on the quality of the seed that is planted and the only way to know the quality factors of purity, vitality, weed seed content and sanitation is to test seed prior to planting. The purpose of this bulletin is to provide teachers and farmers with information about the need for clean seed and methods of testing seed with special emphasis on determination of pure seed, identification of weed and crop seeds, germination tests and use of seed disinfectants for the control of molds that cause disease.

NEED FOR CLEAN SEED

Iowa seed crops that most commonly carry harmful and other weed seeds are oats, barley, wheat, rye, soybeans, flax, red and sweet clover, lespedeza, sudan grass, millets, bluegrass, bromegrass and timothy. Among the small grains, oats are by far the most important in acreage and value; but oats, like all spring-seeded small grains, are not a successful weed competitor. This fact explains why there are so many kinds of weed seeds in oats, as well as in barley, wheat and rye. Seeds of such noxious weeds as Canada thistle, quack grass and mustards commonly occur in the seed of harvested small grain.

Flax is probably the poorest weed competitor of all the

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[1] Project No. 86 of the Iowa Agricultural Experiment Station.

[2] The writer wishes to express his sincere appreciation to George Morris and William Jones for making the drawings used in the illustrations of seeds and seedlings.

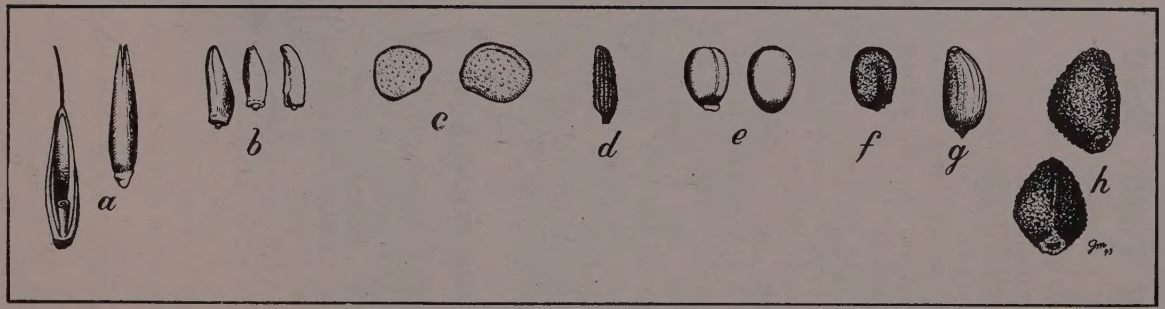

Fig. 1. Seeds of weeds classed as primary noxious in Iowa.
(3 x natural size)

a. Quack grass
b. Canada thistle
c. Horse nettle
d. Perennial sow thistle
e. Leafy spurge
f. Perennial peppergrass
g. Russian knapweed
h. Field bindweed.

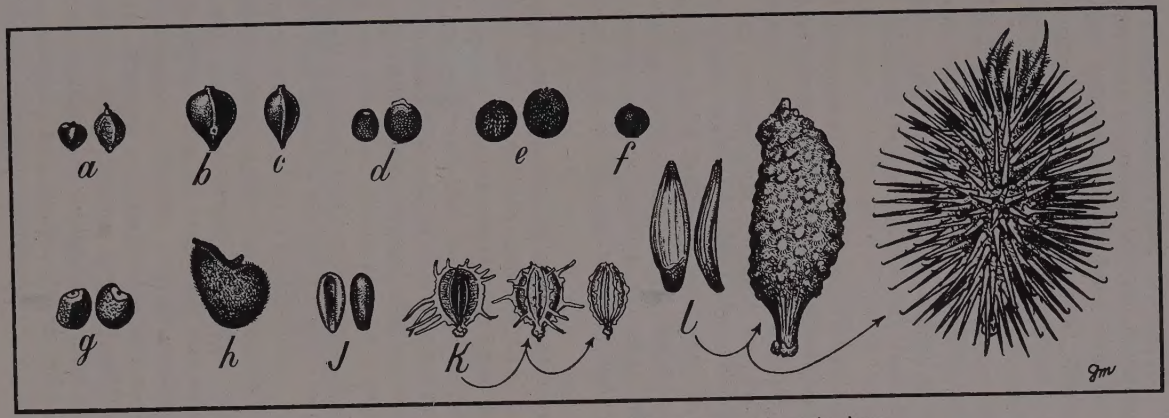

Fig. 2. Seeds of weeds classed as secondary noxious in Iowa.
(3 x natural size except seeds and burs of cocklebur which are 2 x.)

a. Sheep sorrel
b. Smooth dock
c. Sour dock
d. Black mustard
e. Indian mustard
f. Wild mustard
g. Dodder
h. Butterprint
j. Buckhorn
k. Wild carrot
l. Cocklebur

crops listed herein. Unless the land on which flax is grown has received careful cultivation the harvested crop may contain as much as 50 percent weed seeds by weight. The common kinds are false flax, mustards, foxtail, crab grass, barnyard grass, quack grass, pigweeds, smartweeds, dock, sheep sorrel, wild buckwheat, lamb's-quarters and dodder.

Soybean seed commonly contains seeds of butterprint, wild morning-glory and blue field morning-glory, horse nettle berries and seeds and spineless fruits of cocklebur. Clover, lespedeza and grass seed also contain many kinds of weed seeds.

The presence of even a few weed seeds in crop seeds is objectionable from three standpoints: (1) the weeds propagate and further extend their area of infestation, thus increasing the cost of production and lowering land values; (2) it is unlawful to sell crop seed in Iowa when it contains any primary noxious weed seeds or more than 3 percent total weed seeds; and (3) the value and quality of a crop is often reduced by the presence of weed seeds. It is important, therefore, that seed which is to be used for planting should be thoroughly cleaned.

Although there are many farms in Iowa that are equipped with fanning mills, it is unfortunate that only a few of them are equipped to clean any farm seeds efficiently except small grains and soybeans, and many of them do not have sufficient screens to clean oats well. On the other hand, farm fanning mills can remove light weight, diseased grains and such seeds as quack grass, Canada thistle, mustards and seeds of false strawberry and marsh cress when they are shattered from the fruits. Since these five kinds of weeds are among the most common and objectionable in oats it is better to use farm fanning mills than none at all. Many grain elevators and some seed houses have first class equipment for the cleaning of small grains and soybeans. A considerable number are equipped to clean clovers, timothy, lespedeza and bromegrass, but only a few can clean flax properly. It is important, therefore, that farmers consult the local county extension director, the local seedsman or the manager of the local grain elevator for information about seed cleaning.

An idea of the possibility of spreading weeds by crop seeds

may be illustrated by a few examples. For instance, common mustard seeds are small and number about 200,000 per pound. In 1 pound of uncleaned oats from weedy fields there may be as many as 5,000 mustard seeds which would provide enough to scatter 480,000 on each acre of land seeded at the rate of 3 bushels (96 pounds) of infested grain per acre. This amount would provide more than 10 mustard seeds per square foot. In 1 pound of uncleaned red clover seed it is quite common to find 15,000 or more seeds of buckhorn. Such clover seeded at the rate of 8 pounds to the acre would scatter 120,000 buckhorn seeds on each acre or nearly three seeds per square foot. Soybeans produced on land infested with horse nettle commonly carry the berries and seeds of horse nettle in considerable number.

WHO CAN MAKE TESTS?

There is nothing in the Iowa Seed Law which requires that seeds be tested by a state laboratory. Anyone who feels qualified can make a test. Purity tests cannot be made satisfactorily without a balance for weighing the separated fractions. A farmer who sells seed on his own farm and does not deliver it himself is not required to give the percentage of pure seed.

The major requirement of the Iowa law is that the seed be labeled as accurately as possible, and the seller is responsible for what appears on the label regardless of who makes the test. No license is required for anyone to test or sell seeds.

SAMPLING, PACKAGING AND MAILING OF SEED SAMPLES

The first requirement in seed testing is to obtain a representative sample. Seed stocks stored in bulk in a bin should be sampled by collecting a half pint or more from each of several places in the bin. Seed in sacks should be sampled by taking a small amount from each or at least from every 5th or 10th bag. These samples may be mixed thoroughly, then the mixture subdivided by a knife or ruler in such a way that the approximate weight of seed needed for purity or noxious weed test is obtained.

If seed samples are to be mailed to a seed laboratory for analysis the following amounts are preferred:

Timothy, bluegrass, clovers, alfalfa, lespedeza and others of similar size	4 ounces
Flax, rape, sudan grass, sorghum, bromegrass and others of similar size	8 ounces
Small grains, soybeans and corn	1 pound

Cloth bags, heavy seed envelopes or tin boxes are preferable containers for seeds to be sent by mail. *Regular letter envelopes are unsatisfactory because they permit loss of seed.* The outside of the container should show the sender's name and address in legible letters, and an invoice giving the kind of seed should be placed in the container which can be sent parcel post. A letter giving directions for the type of test desired should be sent attached to the package of seed. The package should be addressed to Iowa State College Seed Laboratory, Ames, Iowa.

COST OF TESTING SEED

The seed laboratory is required to make a charge for testing seeds but the cost to Iowa citizens is not enough to pay the cost of testing. The fee for a complete test is 50 cents per sample, for germination only, 40 cents, *cold tests for corn are 50 cents extra,* and "rush tests" are 25 cents more than a regular test. It is necessary to provide a quick service occasionally which accounts for the "rush test" charge. Samples so marked will have a purity test within 48 hours after their receipt. The germination test will be made as soon as possible, depending on the number of days required. Cash or money orders are preferred in payment of accounts. Checks require 5 cents extra for exchange. A deposit to open an account is preferred.

EQUIPMENT FOR TESTING

A modern seed laboratory possesses an array of equipment that the home or school could not afford. There are, however, certain minimum requirements of equipment that are needed before anyone can undertake any kind of reliable

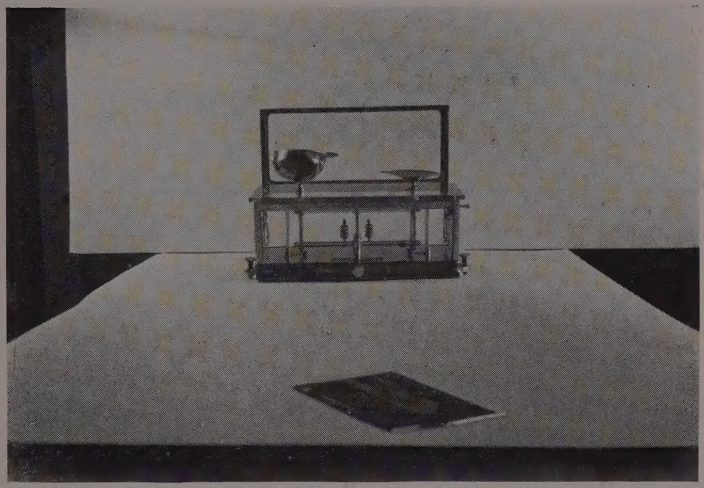

Fig. 3. Torsion balance.

test. The essential things are a balance, a collection of pictures of seeds or actual seed specimens, a magnifying lens, forceps and a germinator.

THE BALANCE

The balance should be one that can weigh to at least 1/10 gram or 1/100 ounce. High schools usually have a chemical balance that is satisfactory. A torsion balance of the type shown in fig. 3 is suitable for most field seeds. A less expensive balance will suffice for large seeds such as corn, soybeans, oats and sorghum, but it is not suitable for timothy and bluegrass.

Fig. 4. Tripod lens.

THE MAGNIFIER

A tripod lens shown in fig. 4 is adequate for use in the home and school although other types, such as a hand

Fig. 5. Forceps

lens, are equally satisfactory. Magnification should be at least 2x natural size.

THE FORCEPS

A pair of forceps will aid greatly in handling small seeds and in making the separations required for a purity test or noxious weed examination. Figure 5 illustrates a preferable type, but one with blunt ends can be used. School children can be supplied with a homemade instrument constructed of spring wire bent to a U-shape and flattened at the ends.

SEED IDENTIFICATION

For seed identification it is helpful to make collections of weed and crop seeds, have them correctly identified, dried and placed in small glass vials. A gummed label with the name of the seed may be pasted on the outside. The college seed laboratory at Ames, Iowa, will identify seeds free of charge. A good substitute for the actual seeds is a set of drawings with the enlarged and the actual size of the seeds. Figures 6 to 18 inclusive will be found of value in seed identification.

THE GERMINATOR

Seed can be tested for germination at home or in school in a number of simple ways. Rolled paper towels or rag dolls may be used for corn, soybeans, peas, oats, wheat, squash and other large seeds. The cloth or paper should be wet, then placed flat on a table, the seeds counted in 50's or 100's and spaced on the moist surface. The towel or cloth may then be rolled somewhat loosely to allow for swelling of the seeds and a string or rubber band placed around each end. The rolls can be wrapped in clean, moist burlap and placed

at the most favorable temperature for germination.

Small seeds such as clover, alfalfa and timothy may be placed between layers of moist blotters, cloths or toweling and laid on a dinner plate which is covered with a second plate to prevent drying. Clean sand can be substituted for the toweling or blotters.

Aluminum pans, as shown in fig. 19, and small wooden

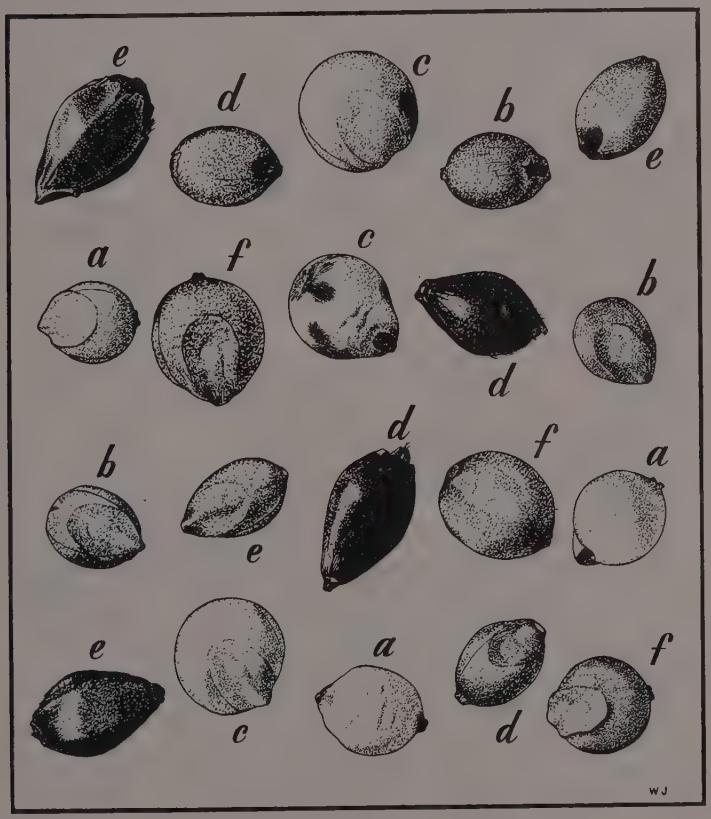

Fig. 6. Seeds of sorghum varieties
(4 x natural size)

a. Atlas
b. Wauconia orange
c. Hegari
d. Black amber (hulless and unhulled)
e. Orange cane (hulless and unhulled)
f. Grohama

flats, as shown in fig. 20, are excellent for germinating large seeds such as cucumber, corn, soybeans, peas, squash, pumpkin and small grains in sand. The seeds are placed between two layers of sand, the top layer being about 1 inch thick. The seedlings that emerge, if normal otherwise, will indi-

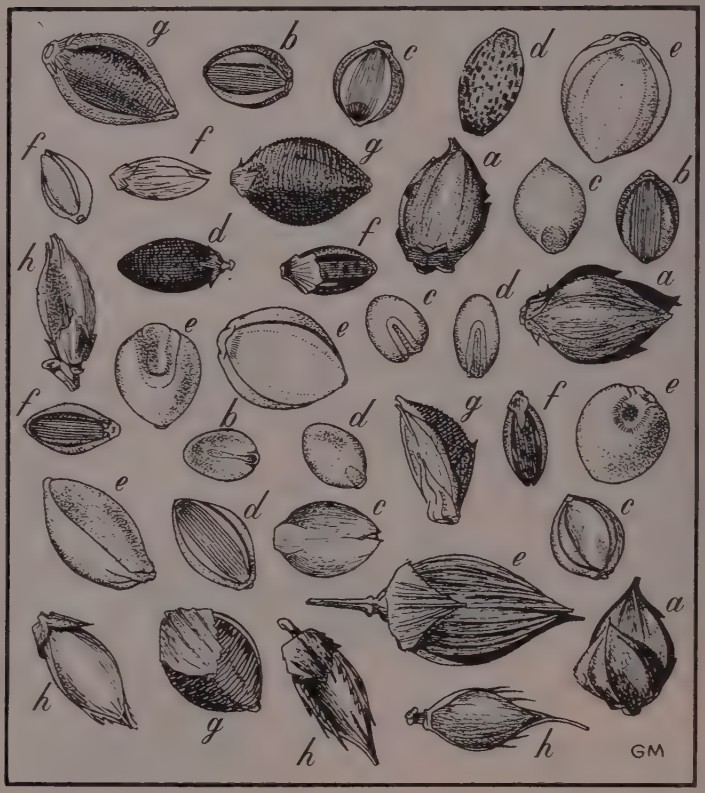

Fig. 7. Seeds of hulless and unhulled millets and foxtails. (7½ x natural size)

a. Japanese millet (barnyard millet)
b. Siberian millet
c. German millet
d. Hungarian millet
e. Broom corn millet (hog millet; proso)
f. Green foxtail
g. Yellow foxtail
h. Barnyard grass

cate the number of viable seeds except for hard seeds which can be recovered by digging in the sand.

There are several commercial types of germinators equipped with temperature control. Among these are the Mangelsdorf, the Minnesota and the Sho-gro. For more refined work with seeds that are sensitive to temperature in germination, a cabinet equipped with temperature control is desirable.

METHODS FOR ANALYZING SEEDS

The methods employed in a seed laboratory for the analysis of seeds are more detailed than are practical for school or home use. To determine approximate purity and germination only the simplest of procedures are presented.

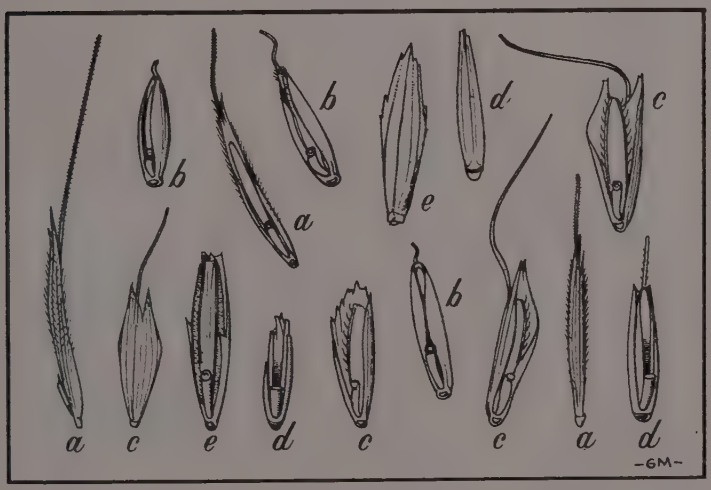

Fig. 8. Seeds of weedy grasses and smooth bromegrass. (3 x natural size)

a. Downy bromegrass
b. Chess or cheat
c. Japanese bromegrass
d. Quack grass
e. Smooth bromegrass (crop)

1. *Purity analysis and detection of noxious weed seeds.*

The size of sample to use for a purity analysis of seeds is determined largely by the kind of seeds and the number in a gram or ounce. Table 1 gives the size of working sample in grams and ounces, the approximate number of seeds per gram and ounce and the weight of sample to use for a noxious weed check.

To obtain the working samples for purity analysis and noxious weed test the bulk sample may be poured onto a table, thoroughly stirred with a spoon, then worked into a broad cone. By means of a knife, ruler or cardboard separate the pile into halves, then divide one of the halves and continue the subdivisions until two samples are obtained, one for noxious weed ex-

Fig. 9. Seeds of sweet clovers.
(7½ x natural size)

a. Hulless and unhulled seeds of white blossom (biennial) sweet clover
b. Golden annual sweet clover
c. Hulless (mottled and not mottled) and unhulled seeds of yellow blossom (biennial) sweet clover
d. Sour clover (annual yellow) sweet clover.
e. Hubam sweet clover (white blossom annual).

amination and one for purity analysis.

To make the noxious weed check the selected subdivision should be poured onto a table or large sheet of white or green paper and by means of a knife or forceps small quantities should be repeatedly drawn from the edge of the pile and examined for weed seeds. Those that are noxious should be laid aside

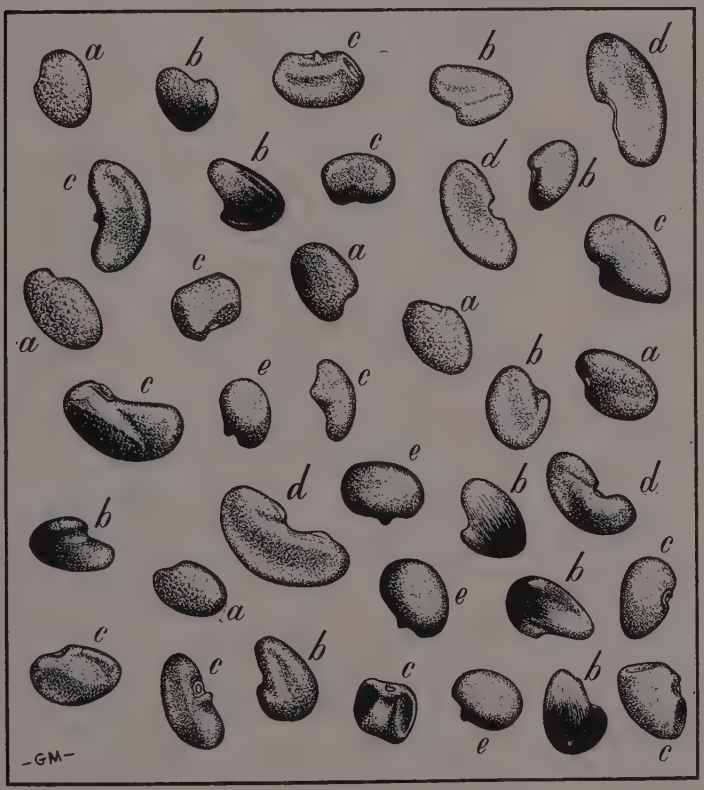

Fig. 10. Seeds of common clovers and alfalfa. (7½ x natural size)
a. Sweet clover
b. Red clover
c. Alfalfa
d. Bur clover
e. Black medick

until the entire pile has been examined, when the number should be determined. The Iowa Seed Law makes it unlawful to sell crop seed containing seeds of primary noxious weeds and requires that the number of secondary noxious weed seeds per ounce or pound be shown on the label or placard. Figures 1 and 2 illustrate the seeds of the primary and secondary noxious weeds listed in the Iowa Seed Law.

To make the purity analysis the small working sample should be poured in a pile as described in the preceding paragraph, but it must be examined in detail, all the particles classified and placed in one of four

TABLE 1. APPROXIMATE WEIGHT IN GRAMS AND OUNCES OF SAMPLES FOR PURITY ANALYSIS AND NUMBER OF SEEDS PER UNIT WEIGHT.

Kind of seed	Wt. for analysis		Approximate number seeds per		Weight for noxious weed test ounces
	Grams	Ounces	Gram	Ounce	
Alfalfa	5	0.2	500	14,170	2
Barley	50	2.0	30	850	16
Bluegrass	1	0.05	4800	136,000	1
Bromegrass	5	0.2	300	8,500	2
Buckwheat	50	2.0	45	1,275	8
Alsike clover	2	0.1	1500	42,520	2
Red clover	5	0.2	600	17,010	2
Sweet clover	5	0.2	570	16,160	2
Flax	10	0.4	300	8,500	2
Sudan grass	25	1.0	120	3,400	5
Korean lespedeza	5	0.2	525	14,880	2
Broom corn millet	25	1.0	180	5,100	5
Foxtail millet	5	0.2	470	13,320	2
Japanese millet	5	0.2	310	8,780	2
Oats	50	2.0	28	790	16
Rape	10	0.4	230	6,520	2
Rye	50	2.0	40	1,130	16
Ryegrass	5	0.2	500	14,170	2
Sorghum	50	2.0	55	1,560	8
Soybean	100	4.0	7	198	16
Timothy	2	0.1	2500	70,870	2
Wheat	50	2.0	25	708	16

classes, namely, (1) pure seed of the kind being tested, (2) seeds of other crop plants, (3) weed seeds and (4) inert material. Broken crop seeds, either of the kind being tested or of other crops, are classed as seeds if over half the seed is present. All other broken

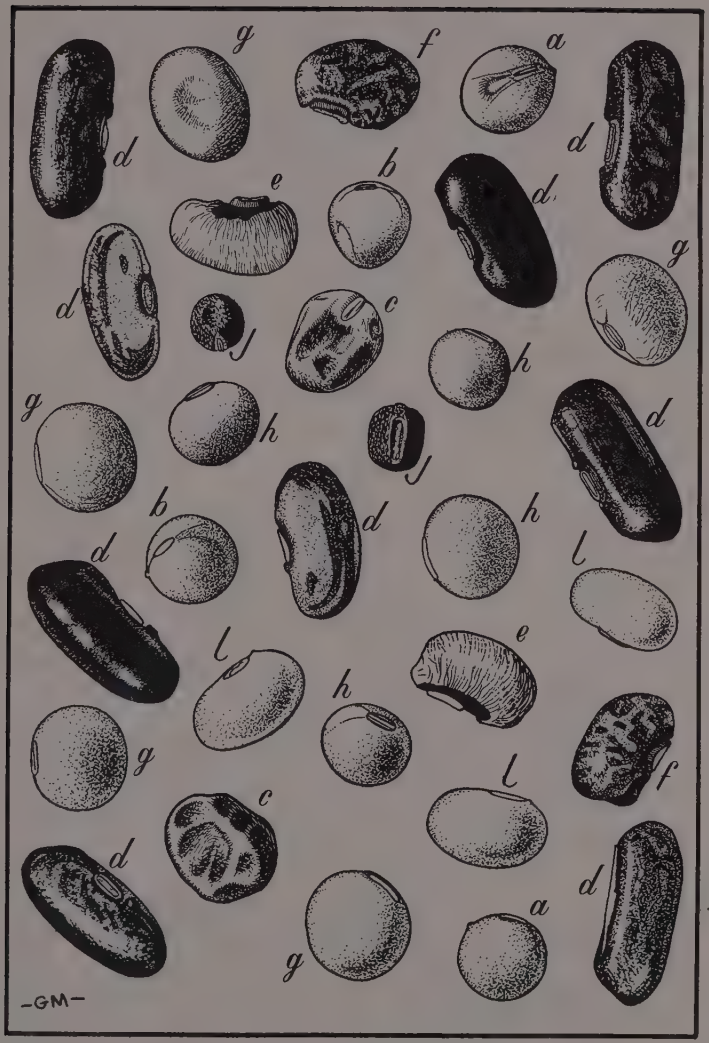

Fig. 11. Seeds of peas and beans
(2 x natural size)

a. Canada field pea
b. Garden pea (Alaska)
c. Garden pea (Perfection)
d. Garden bean (several varieties)
j. Sweet pea
e. Cowpea (Black eye)
f. Cowpea (Whippoorwill)
g. Soybean (Bansei)
h. Soybean (Mukden)
l. Navy bean.

crop seeds are placed in the inert fraction. Weed seeds that are badly broken, cracked or otherwise injured are classed as inert material provided that they are considered incapable of germination. Inert material includes stems, leaves, dirt, stones, chaff, undeveloped buds, fungus bodies such as smut balls and ergot and all other material not seeds.

When the separation has been completed each fraction is weighed separately, the total weight determined and the percentage of each fraction is calculated. An illustration of the procedure follows:

Oat test	Weight in ounces	Percent by weight
Sample before analysis	2.10	
Pure seed after analysis	1.75	85.3
Other crop seed	.10	4.9
Inert material	.10	4.9
Weed seed	.10	4.9
TOTAL AFTER ANALYSIS	2.05	100.00

$$\frac{1.75}{2.05} = .853 \times 100 = 85.3 \text{ percent}$$

$$\frac{.10}{2.05} = .488 \times 100 = 4.9 \text{ percent}$$

The reduction in original weight could be caused by loss of particles, loss in moisture or inaccuracy of the scale for weighing in small amounts.

2. *Germination Tests.*

Seed viability is best determined by laboratory tests. The first requirement in making germination tests is to select pure seed of the kind to be tested. Other requirements are an adequate supply of moisture, favorable temperature and good aeration. Some seeds will germinate only at low, some only at high and others at alternating temperatures. Many kinds will germinate well over a wide range of temperature although the rate of germination varies greatly.

The temperature requirements for some of the com-

mon field and vegetable crop seeds together with the length of time required for a test and the kind of medium for best results are given in table 2. In those cases where a range in temperature is given the low one should be maintained at night and the high one in the day time. Whenever sand is used for cucumber, cantaloupe, pumpkin, squash, watermelon, peas, beans and soybeans, it should first be sterilized with heat. This may be done at home by heating in an oven at medium heat for 3 hours. In a laboratory the sand can be heated in a Dutch oven over an electric plate for 5 hours.

The rolled towel test for corn, the blotter test for clovers and the sand test for soybeans are illustrated in figs. 21, 22 and 23. In each type of test the impor-

Fig. 12. Alsike and white clover with associated weed seeds. (7½ x natural size)

a. Alsike clover
b. White Dutch clover
c. Timothy
d. Canada thistle
e. Dog fennel (Mayweed)
f. Night-flowering catchfly

tant objective is to classify the seedlings in terms of plant producing ability.

3. *Interpretation of Tests.*

An analysis or test of seed is of most value when it is carefully interpreted. This involves consideration of the purity and weed seed content, the viability and whether or not the seed is diseased.

Seed lots with a relatively high purity are superior to others, but the character of the impurities must also be considered. For example, other crop seed in a sample may increase the seeding value even though the purity is lowered. Weed seeds reduce the seeding value, in fact, the presence of primary noxious weed seeds disqualifies a seed lot either for sale or for planting. The use of seed lots containing secondary noxious weed seeds will depend largely on the amount present and the availability of seed free from such weed seeds. The possibility of removing the weed

Fig. 13. Seeds of lespedeza and associated weed seeds. ($7\frac{1}{2}$ x natural size)

a. Common lespedeza (hulless and unhulled)
b. Korean lespedeza (hulless and unhulled)
c. Kobe lespedeza (hulless and unhulled)
d. Horse nettle
e. Dodder

Fig. 14. Seeds of flax and associated weed seeds
(7½ x natural size)

a. Flax
b. Wild buckwheat (with and without calyx)
c. Bigseed and smallseed lady's thumb (with and without calyx)
d. False flax
e. Flax dodder.

Fig. 15. Sudan grass with associated weed seeds.

a. Hulless and unhulled sudan grass seeds
b. Hulless and unhulled Johnson grass seeds
c. White horse nettle.

seeds by cleaning must also be considered. To aid in the evaluation of seed lots containing seeds of noxious weeds, the primary and secondary species are listed herewith:

NOXIOUS WEED SEEDS ACCORDING TO IOWA SEED LAW.

Primary	Class	Secondary	Class
Canada thistle	Perennial	Butterprint	Annual
Field bindweed	"	Cocklebur	"
Horse nettle	"	Dodders	"
Leafy spurge	"	Mustards	"
Perennial peppergrass	"	Wild carrot	Biennial
Perennial sow thistle	"	Buckhorn	Perennial
Quack grass	"	Sheep sorrel	"
Russian knapweed	"	Smooth dock	"
		Sour dock	"

Drawings of the seeds of each species of the noxious weeds are shown in figs. 1 and 2.

In germination tests it is necessary to consider the relative vigor of the sprouts that make up a sample. In general, the older the seed the less vigorous the seedlings, thus indicating declining vitality. In seed-testing practice it has been found necessary to classify seedlings into two groups, normal and abnormal. Normal seedlings are defined as those that develop structures considered essential for continued growth as normal plants, under favorable field conditions. For most seedlings the primary root and primary stem are essential and each should show evidence of healthy growth. All other seedlings are classed as abnormal, weak or subnormal. Figures 24, 25, 26, 27, 28 and 29, illustrate normal and abnormal seedlings of sweet clover, timothy, corn, soybeans, flax and lespedeza. These plates will also serve as a guide for the interpretation of tests made with seeds of other crop plants.

Viability is expressed in percentage of germination, which means the number of seeds out of each 100 that produced normal seedlings. For example, if 180 normal sprouts are obtained from 200 seeds in a test of oats, the percentage germination is 90. Seeding rates frequently need to be adjusted according to the vitality of the seed. In addition, allowance should be made for hard (impermeable) seeds that

TABLE 2. REQUIREMENTS FOR TESTING THE VIABILITY OF SEEDS.

Kind of crop	Seedbed	No. days to germinate	Temperature °F.
Field crops			
Barley	Sand or blotters	8 to 10	68
Bluegrass	Blotters	28	68-87
Bromegrass	Blotters	14	68-87
Buckwheat	Blotters	6	68-87
Corn	Sand	6 to 8	80
Clovers and alfalfa	Blotters	7	68
Flax	Blotters	5	68-87
Lespedeza (Korean)	Blotters	14	68-95
Millets	Blotters	10	68-87
Oats	Sand or blotters	8	68
Rape	Blotters	7	68-87
Rye	Sand or blotters	8 to 10	68
Ryegrass	Blotters	14	68-87
Soybeans	Sand	5 to 7	85
Sudan	Blotters	10	68-87
Timothy	Blotters	10	68-87
Wheat	Sand or blotters	8 to 10	68
Vegetable crops			
Beans	Sand	8 to 10	80-85
Beets	Blotters	14	68-87
Cabbage	Blotters	10	68-87
Carrot	Blotters	28	68-87
Cucumber	Sand or blotters	6 to 8	85
Muskmelon	Sand or blotters	6 to 8	85
Eggplant	Blotters	14	68-87
Onion	Blotters	14	68
Peas	Sand	8	68
Pepper	Blotters	14	68-87
Pumpkin	Sand	7 to 10	85
Squash	Sand	7 to 10	85
Radish	Blotters	5	68
Spinach	Top of sand	21	50
Tomato	Blotters	14	68-87
Watermelon	Sand	14	85

occur in clovers, alfalfa, lespedeza, beans, peas, okra and asparagus. Hard seeds in alfalfa, soybeans, peas, garden beans and lespedeza usually germinate soon enough after planting in the field to justify their inclusion with readily germinable seeds in determining rates of seeding. In red and alsike clover about half and in sweet clover about one-third to one-half the hard seeds may be considered germinable the year they are planted. The earlier in the spring that clover seeds are planted the higher the percentage of hard seeds that will germinate that season.

Other factors that need to be considered are diseases and the availability and value of seed treatments. For example,

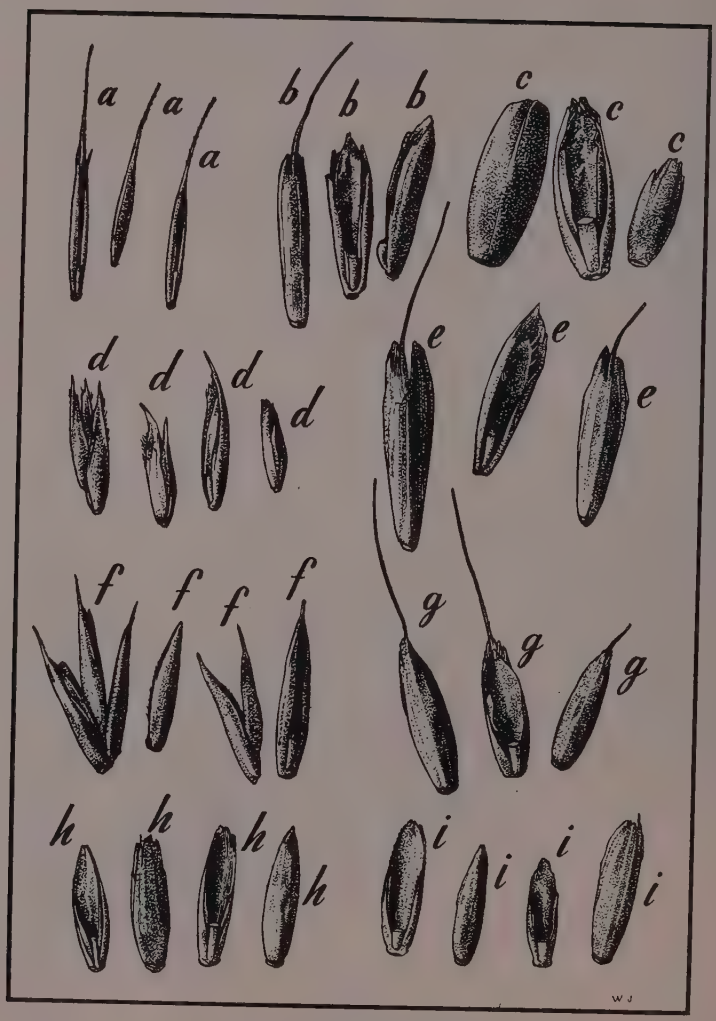

Fig. 16. Seeds of grasses
(4 x natural size)

a. Rat-tail fescue
b. Cheat
c. Darnel
d. Orchard grass
e. Japanese brome
f. Crested wheat
g. Annual ryegrass
h. Meadow fescue
i. Perennial ryegrass

TABLE 3. IOWA STANDARDS FOR SEED CERTIFICATION AND RATES OF SEEDING FOR SEEDS SOWN SEPARATELY.

Kind of crop	Lowest requirements for certification (blue tag)		Index value*	Recommended seeding rate, lbs. per acre
	Purity	Germination		
Bromegrass	85	80	68.0	10
Barley	97	90	87.3	96
Corn	100	90	90.0	8
Clover, red	97	90	87.3	8
Clover, sweet	97	90	87.3	10
Flax	97	90	87.3	45
Lespedeza, Korean	97	90	87.3	25
Oats	97	90	87.3	96
Soybeans	97	90	87.3	60
Wheat	97	90	87.3	90

* Index value is $\frac{\text{purity} \times \text{germination}}{100}$ = pounds per hundred of pure, germinable seed. Percentage germination includes hard seeds in the leguminous crops.

the seeding value of wheat, barley, oats, corn, flax and peas may be increased 10 to 25 percent by seed treatment, particularly if the seeds are infected with organisms that injure germination and/or if adverse field conditions for germination prevail immediately after planting.

The application of seed testing results to the adjustment of seeding rates is dependent not only on the quality of the

Fig. 17. Seeds of cereals.
(2 x natural size)

a. Wheat
b. Oat (hulless and unhulled)
c. Barley (hulless and unhulled)
d. Rye

seed but also on such environmental factors as seedbed preparation, methods of seeding, physical condition of the soil, temperature and rainfall, soil fertility and the chemical condition and fungus population of the soil. It is necessary to refer to a standard quality for each kind of seed before any adjustment in seeding rate is attempted. The standards of seed quality for several crops eligible for certification in Iowa are given in table 3. With these standards as a guide it is possible to determine the approximate seeding rate for a given lot of seed, provided that due consideration is given to time of seeding and other factors of soil, rainfall, temperature, etc.

To determine rate of seeding by index value the formula to employ is:

$$\frac{\text{Standard Index Value} \times \text{Recommended Seeding Rate}}{\text{Index Value of Sample}} = \text{Adjusted Seeding Rate.}$$

An application of this formula may be given by assuming a sample of oats with a purity of 95 percent and a germination of 80 percent. When these values are substituted in the formula the result is:

$$\frac{87.3 \times 96}{\frac{95 \times 80}{100}} = \frac{87.3 \times 96 \times 100}{95 \times 80} = \frac{838080}{7600} = 110.3 \text{ pounds}$$

For some crops, such as barley, oats, flax, soybeans and clovers, the number of seeds per pound varies considerably among varieties, hence another factor affecting seeding rates is introduced. Varietal differences as to stooling and branching are additional factors which must be considered when an adjustment is made in rate of seeding. Experience and familiarity with a variety will aid in a decision.

SEED TREATMENT

One of the important developments in seed testing is that certain chemicals when applied to seeds will prevent the development of molds that injure germination, make it easier to evaluate the sprouts and result in an increased number of normal seedlings. Furthermore, it has been found that seed treatment will protect seeds from injury by soil or-

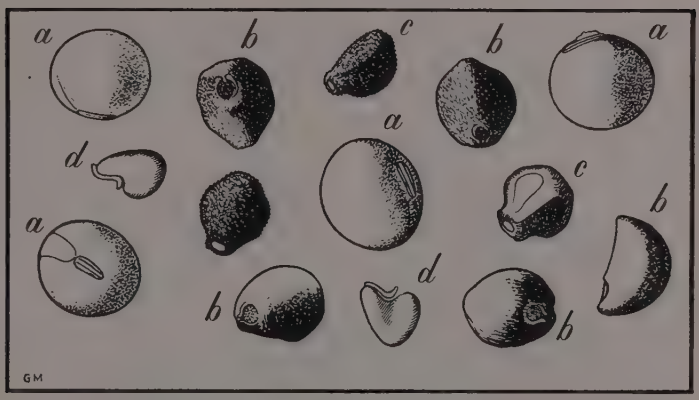

Fig. 18. Seeds of soybean and common weed impurities. (2 x natural size)

a. Mukden beans
b. Annual morning-glory
c. Wild morning-glory
d. Butterprint

ganisms when conditions are unfavorable for rapid seed germination. An abundance of soil moisture and a low temperature favor the growth of many soil organisms and retard the germination of seeds.

A comparison between laboratory and field germination of treated and untreated seeds shows that laboratory tests, properly conducted, will often indicate field response under either favorable or unfavorable conditions. For example, if barley seeds are infected with the scab organism and treated and untreated seeds are germinated at favorable temperatures in the laboratory, the difference between treated and untreated as found in the laboratory will be fairly well maintained in the field. If field temperature and moisture are favorable for barley seed germination one can expect about the same percentage germination in the field as in the laboratory.

On the other hand if good seed corn is tested in natural soil in the laboratory at 50°F. for 7 days and then transferred to 80°F. for 3 days the germination may be very low, although seed treated with a chemical dust will give a much better germination than untreated seed. If treated and untreated seed of such a sample is planted in the field when conditions for seed germination are favorable there may be

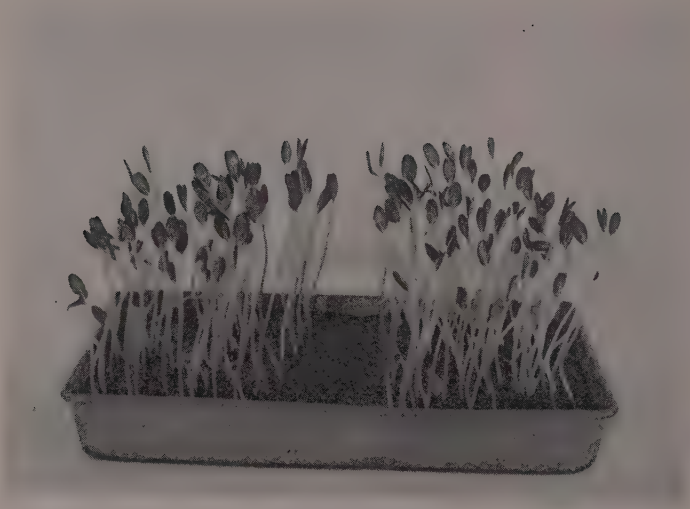

Fig. 19. Aluminum pan used to germinate seeds in sand. (cucumber seedlings)

Fig. 20. Small wooden flat 7" x 14" showing corn seedlings in sand.

relatively little difference in the germination of treated and untreated seed. On the other hand, if field conditions are decidedly unfavorable one can expect the treated seed to produce a much better stand than the untreated. Under such field conditions the results will be similar to those in natural soil in the laboratory.

The more common crop seeds for which seed treatment is recommended are listed in table 4 together with the kind and amount of treatment to use. Before any treatment is applied one should first determine if the seed has already been treated. Seed of hybrid corn and a few kinds of vegetable crop seeds are frequently treated before sale to the consumer. Double treatment is not only unnecessary but may result in injury. *Some of the dusts, particularly mercury compounds, are poisonous and great care must be exercised in their use.*

Seeds of cereals, flax and sugar beets are best treated at seed treatment centers where large-capacity equipment is available. Many Iowa counties have such centers, and their location can be learned from the offices of the county extension directors. A revolving drum or churn may be used for half-bushel or bushel lots. Small quantities of vegetable crop seeds may be treated in a fruit jar of a size such that it is not more than ⅓ full of seed at a time. The seed should be weighed, the calculated amount of dust added and the seed and dust shaken in the jar for at least 3 minutes or until the dust is well distributed on the seeds. Such compounds as Arasan, Spergon, copper carbonate, Merko, Barbak C, Semesan Jr., zinc oxide and Cuprocide may be applied in excess prior to shaking and the excess screened off by pouring the treated seed into a tea strainer or sieve.

VARIATION IN SEED SAMPLES.

Experience in seed testing and repeated tests from the same lot of seed have shown that no two samples obtained from a particular lot are exactly the same. Differences between replicate samples from a particular lot are of regular occurrence and an allowance must be made for the differences.

If a sample of seed is free from all foreign matter and

Fig. 21. Rolled towel test of corn.

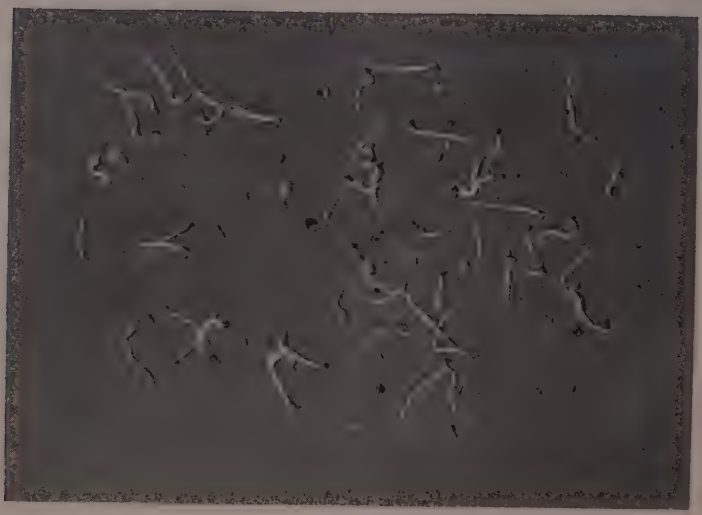

Fig. 22. Germination of red clover seed in a blotter.

Fig. 23. Germination of soybeans in sand.

other seed impurities it should be practically 100 percent pure. This seldom occurs except in the case of such seeds as corn, beans, peas, squash, pumpkin and watermelon. If repeated sub-samples are drawn from seed of such quality, each should show practically 100 percent pure seed. Similarly, if a lot has 100 percent germination, each sub-sample should test 100 percent.

For the most part seed lots fall below 100 percent in both purity and germination, and the nearer the decline approaches the 50 percent point the greater the differences to be expected between a given set of sub-samples drawn from the bulk. For example, if two lots of seed have a mean purity percentage of 95 and 80 respectively and 10 sub-samples are drawn from each lot, the differences between the replicates from the first lot should be less than from the second even though both lots were equally well mixed and homogeneous.

The Iowa Seed Law and the Federal Seed Act recognize that consideration must be given to differences in samples drawn from a given bulk lot of seed or from different por-

tions of a lot at different times by different people. For example, a shipper or vendor may obtain what he considers a representative sample from a bulk lot, have it tested and labeled accordingly. A purchaser who receives part or all of the lot may then draw a sample for test or a seed inspector may draw a sample. Comparison of the data on the label is then made with the data obtained later. A basis of evaluating the two sets of data is necessary either for payment by the purchaser or for decision as to correct or incorrect labeling of the seed.

To facilitate decisions, rules of tolerance have been established for purity, weed and crop seed content, inert matter and germination. The formula for determining tolerance in purity percentages is $T = 0.6 + (0.2 \times \frac{a \times b}{100})$ where

Fig. 24. Sweet clover seedlings.
(5 x natural size)
a, b and c — normal seedlings; d to n inclusive — broken, malformed and weak seedlings classed as abnormal.

T = tolerance, a = percentage pure seed and b = 100 — a. To illustrate the use of the formula assume a lot of seed is labeled 95.6 percent pure seed and the inspector's sample shows 94 percent pure. The computation is $T = 0.6 + \left(0.2 \times \frac{94 \times 6}{100}\right) = 1.728$.

94 + T = 94 + 1.728 = 95.728 which is greater than 95.6 as claimed, hence the lot would not be considered mislabeled.

This formula is used for all kinds of seed except such chaffy grasses as bluegrass, orchard grass, bromegrass, wheat grasses and redtop. For chaffy grasses an additional tolerance is allowed; namely, by adding to the regular tolerance described, the product obtained by multiplying "T" by the lesser of "a" and "b" divided by 100. To illustrate the application assume a lot of bluegrass labeled 90 percent pure seed and the inspector's sample shows 85. First the regular tolerance is computed: $T = 0.6 + \left(0.2 \times \frac{85 \times 15}{100}\right) = 3.15$.

The additional tolerance is $T \times \frac{15}{100} = .47$. The total tolerance is then 3.15 + .47 = 3.62 and 85 + 3.62 = 88.62 which is less than 90, the percent claimed, and the lot would be considered as mislabeled.

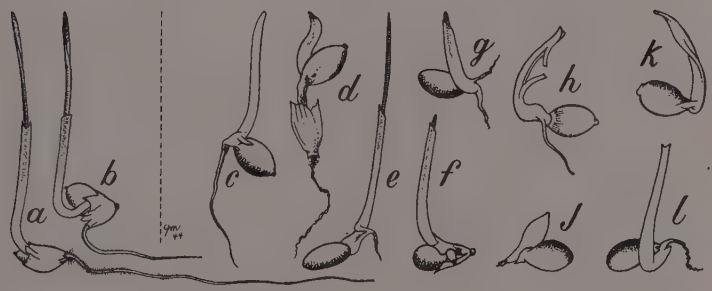

Fig. 25. Timothy seedlings.
(8 x natural size)
a and b — normal; c to l inclusive — abnormal; c and l — no plumule, only the coleoptile

Tolerance for weed seeds, other crop seeds and inert matter is computed by the formula $T = 0.2 + (0.2 \times \frac{a \times b}{100})$

TABLE 4. DUST TREATMENT* FOR FIELD AND VEGETABLE CROP SEEDS.

Kind	Recommended treatment	Rate of application
Field crops		
Barley	New Improved Ceresan	½ oz. per bu.
Corn	Arasan Semesan Jr., Barbak C Merko, Spergon	1¼ to 1½ oz. per bu.
Flax	New Improved Ceresan	½ oz. per bu.
Oats	New Improved Ceresan	½ oz. per bu.
Sorghum	Ceresan—2 percent Copper carbonate	2 oz. per bu. 2 oz. per bu.
Wheat	New Improved Ceresan Copper carbonate	½ oz. per bu. 2 oz. per bu.
Sugar beets	New Improved Ceresan	5 oz. per 100 lbs.
Vegetable crops		
Beets	Cuprocide or Arasan	1% by weight (1/5 oz. per lb. of seed)
Peas	Arasan Spergon Semesan	1.5 oz. per bu. 1.5 to 2 oz. per bu. 2.5 oz. per bu. (60 lbs.)
Spinach	Arasan Zinc oxide Cuprocide	25 percent by weight 2 percent by weight 1/3 oz. per lb. of seed
Sweet corn	Arasan Barbak C. Merko, Semesan Jr., Spergon	1¼ to 1½ oz. per bu. (56 lbs.)
Melons and cucumbers	Semesan Cuprocide	3/4 oz. to 15 lbs. seed 6/10 oz. to 15 lbs. seed

* Most of the products listed in this table can be purchased either from local druggists, seed houses or wholesale drug companies.

Recognized tolerances applicable to percentage of germination and to the sum of the germination and hard seed are as follows:

Found by test	Tolerance
96 or over	5
90 or over but less than 96	6
80 or over but less than 90	7
70 or over but less than 80	8
60 or over but less than 70	9
Less than 60	10

The application of these tolerances is as follows: Assume a lot labeled 90 percent germination and the inspector's sample gives 83 percent. The tolerance is applied to what is found (83) which is 7 and 83 + 7 = 90 hence the lot would not be considered mislabeled.

DIGEST OF THE IOWA SEED LAW[3]

There are four main features of the new Iowa Seed Law which need discussion; namely, (a) list of noxious weeds, (b) labeling requirements, (c) prohibited sales and (d) exemptions.

A. Noxious weed seeds are divided into two classes as follows:

Primary		Secondary	
Common name	Botanical name	Common name	Botanical name
Quack grass	*Agropyron repens*	Wild carrot	*Daucus carota*
Canada thistle	*Cirsium arvense*	Sour dock	*Rumex crispus*
Perennial sow thistle	*Sonchus arvensis*	Smooth dock	*Rumex altissimus*
Perennial peppergrass	*Lepidium draba*	Sheep sorrel	*Rumex acetosella*
Field bindweed (Creeping Jennie)	*Convolvulus arvensis*	Butterprint	*Abutilon theophrasti*
Horse nettle	*Solanum carolinense*	Mustards	*Brassica* spp.
Leafy spurge	*Euphorbia esula*	Cocklebur	*Xanthium commune*
Russian knapweed	*Centaurea repens*	Buckhorn	*Plantago lanceolata*
		Dodder	*Cuscuta* spp.

B. All seed dealers and farmers who sell seed off their own farms are required to supply the following information, on a label if in bags, or placard if sold in bulk:

(1) Commonly accepted name of (a) kind, or (b) kind and variety or (c) kind and type of each agricultural seed component in excess of 5 percent of the whole and the percentage by weight of each in the order of its preponderance.

(2) Lot number or other lot identification.

[3] Enforcement of the Iowa Seed Law is under the jurisdiction of the Secretary of Agriculture at Des Moines, Iowa, and all inquiries concerning its enforcement should be sent to him.

(3) Origin, if known, of alfalfa and red clover. If the origin is unknown, that fact shall be stated.

(4) Percentage by weight of all weed seeds.

(5) The name and approximate number of each kind of secondary noxious weed seed, per ounce in groups (a), (b) and (c) and per pound in group (d), when present singly or collectively in excess of—

(a) Five seeds or bulbets per ounce of redtop, Bermuda grass, bluegrass, timothy, orchard grass, fescues (except meadow fescue), alsike and white clover, reed canary grass and other agricultural seeds of similar size and weight, or mixtures within this group.

(b) Three seeds or bulbets per ounce of ryegrass, meadow fescue, foxtail millet, alfalfa, red

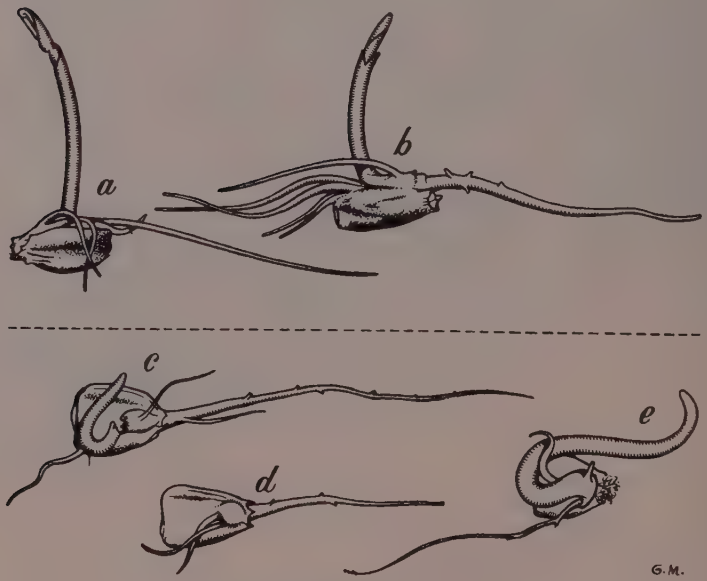

Fig. 26. Corn seedlings.
(Natural size)
a — classed as normal but without primary root; b — normal;
c, d and e — abnormal

Fig. 27. Soybean seedlings (1½ x natural size)
a and b — normal; c, d and e — weak (abnormal);
f, g and h — baldheads (abnormal)

clover, lespedeza, smooth brome, crimson clover, *Brassica* spp., flax, *Agropyron* spp. and other agricultural seeds of similar size and weight or mixtures within this group, or of this group with (a).

(c) One seed or bulbet per ounce of proso, sudan grass and other agricultural seeds of similar size and weight, or mixtures not specified in (a), (b) or (d).

(d) Five seeds or bulbets per pound of wheat, oats, rye, barley, buckwheat, sorghum (except sudan grass), vetches, soybeans and other agricultural seeds of a size and weight similar to or greater than those within this group.

All determinations of noxious weed seeds are subject to tolerances and methods of determination prescribed in the rules and regulations under this act.

(6) Percentage by weight of agricultural seeds other than

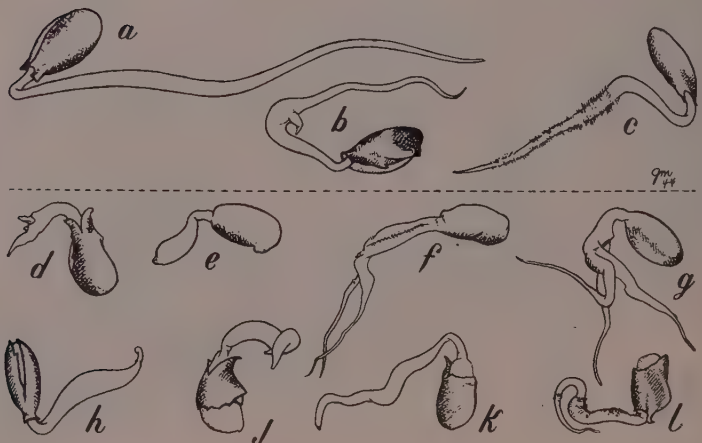

Fig. 28. Flax seedlings.
(4 x natural size)
a, b and c — normal; d to l inclusive — types of abnormal seedlings

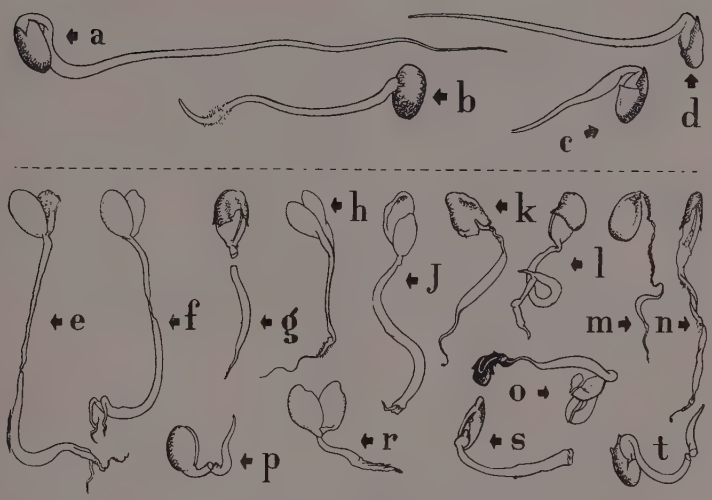

Fig. 29. Korean lespedeza seedlings.
(5 x natural size)
a, b, c and d — normal; e to t inclusive — types of abnormal seedlings

those required to be named on the label.

(7) Percentage by weight of inert matter.

(8) For each named agricultural seed (a) percentage of germination exclusive of hard seed, (b) percentage of hard seed, if present, and (c) the calendar month and year the test was completed to determine such percentages. Following (a) and (b) the additional statement "total germination and hard seed" may be stated as such if desired.

(9) Warning as to danger from poisoning in the case of treated seed if compound is used which is poisonous to man or farm animals.

(10) Name and address of the person who labeled said seed, or who sells, offers or exposes said seed for sale within this state.

Sale by Grower on His Own Farm

A grower who sells on his own farm either in bulk or in containers may be exempt from the labeling provisions re-

ferred to provided that either a placard is displayed or a written or printed statement is supplied to the purchaser with the following information:

(1) The percentages of germination and hard seeds of the seed being sold together with the calendar month and year said seed was tested to determine the percentage.

(2) The kind and number per ounce or pound of all secondary noxious weed seeds in the lot when in excess of the amounts given under B (5), pages 296 and 298.

(3) A guarantee that no primary noxious weed seeds are present.

C. Prohibited sales.

It is unlawful for any person to sell, offer for sale or expose for sale within Iowa,

(1) Any agricultural seed:

(a) Unless the test to determine the percentage of germination required by section 3 shall have been completed within a 9-month period, exclusive of the calendar month in which the test was completed, immediately prior to sale, exposure for sale, or offering for sale or transportation.

(b) Not labeled in accordance with the provisions of the act, or having a false or misleading label.

(c) Pertaining to which there has been a false or misleading advertisement.

(d) Containing any primary noxious weed seeds subject to tolerances and methods of determination prescribed in the rules and regulations.

(e) Containing more than 3 percent weed seeds.

(2) Screenings of any agricultural seed unless it is stated on the label if in containers, or on the invoice, if in bulk, that they are not intended for seeding purposes.

It is further unlawful for any person—

(a) To detach, alter, deface or destroy any label provided for in the act.

(b) To disseminate any false or misleading advertisement concerning agricultural seed in any manner or by any means.

(c) To hinder or obstruct in any way any authorized person in the performance of his duties.

(d) To fail to comply with a "stop sale" order.

D. Exemptions.

Labeling provisions and prohibitions do not apply to—

(1) Seed or grain not intended for sowing purposes.

(2) Seed in storage in or consigned to a seed cleaning establishment for cleaning or processing.

Regulations for Hybrid Seed Corn and Seed Potatoes

Sale of hybrid seed corn and seed potatoes is regulated as follows:

Section 5—It shall be unlawful for any person to sell, offer or expose for sale or falsely mark or tag, within the state of Iowa any seed corn as hybrid unless it represents the first generation of a cross between strains of different parentage and involving inbred lines of corn and (or) their combinations. Any corn sold as "hybrid" shall have plainly printed or marked on the label or container in which such corn is sold the identifying symbol or numbers, clearly indicating the specific combination. The cross mentioned above shall be produced by cross fertilization, controlled either by hand or detasseling at the proper time.

Section 7—It is hereby established that a certification system is essential to the supply of good seed potato stocks for the state of Iowa and that long usage of a blue tag attached to bags containing certified seed by authorities in states where certified seed potatoes are produced has become identified in the public mind as evidence of superior quality and of official certification.

It shall be unlawful for any person to sell, offer for sale or expose for sale in the state of Iowa—

(1) Any seed potatoes with a blue tag attached, unless same are certified.

(2) Any seed potatoes as "certified" unless

(a) Each bag bears a label blue in color with the word "certified" thereon.

(b) Such seed has been certified by a duly constituted state authority or state association in the state in which the seed was produced, said state authority or association to be recognized by the Iowa secretary of agriculture.

LIST OF PUBLICATIONS THAT MAY BE USEFUL IN CONJUNCTION WITH THIS BULLETIN

Testing farm seeds in home and school.
United States Department of Agriculture. Misc. Publication No. 437 by Albina F. Musil. 1942.

Laboratory tests of field crop seeds as indicators of seeding value. Iowa Agricultural Experiment Station Research Bulletin 239 by E. L. Erickson and R. H. Porter. 1938.

Indexing farmers seed lots for seed borne organisms and response to seed disinfectants. Iowa Agricultural Experiment Station Research Bulletin 238, by R. H. Porter. 1938.

Hard seeds in legumes. Mont. Agricultural Experiment Station Bulletin No. 248 by W. O. Whitcomb. 1931.

The vitality of buried seeds. Jour. Agr. Research Vol. 29 pp. 349-362 by W. L. Goss. 1924.

The viability and germination of seeds of *Convolvulus arvensis* L. and other perennial weeds. Iowa Agricultural Experiment Station Research Bulletin 242, by E. O. Brown and R. H. Porter. 1942.

Weeds and weed seeds. Published by Seed World, Chicago, Ill. 1940.

Noxious and other bad weeds of Iowa (Revised)
Iowa Agricultural Experiment Station and Extension Service Bulletin P64 by E. P. Sylwester and R. H. Porter.

Weeds by W. C. Muencher, published by the MacMillan Co., New York. 1935.

Representative Missouri weeds and their control. Mo. Agr. Experiment Station Bulletin 433 by W. B. Drew and C. A. Helm. 1941.

Weeds in Kansas. Kansas State Board of Agriculture Report No. 243. By Frank C. Gates. 1941.

Rules and regulations under the federal seed act. U. S. Dept. of Agriculture Service and Regulatory Announcements No. 156. 1939.

Law relating to agricultural seeds. Iowa Department of Agriculture, Des Moines, Iowa. 1941.

Rules and regulations relating to Iowa seed law. Iowa Department of Agriculture, Des Moines, Iowa. 1941.

Iowa laws relating to noxious weeds. Bul. No. 81. Iowa Dept. of Agriculture, by I. E. Melhus, R. H. Porter and E. P. Sylwester. 1939.

Cooperative Extension Work in Agriculture and Home Economics, Iowa State College of Agriculture and Mechanic Arts and the United States Department of Agriculture cooperating. Extension Service, R. K. Bliss, director, Ames, Iowa. Distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914.

Agricultural Experiment Station, Iowa State College of Agriculture and Mechanic Arts, R. E. Buchanan, director, Ames, Iowa.